LEUPOLD®

TACTICAL OPTICS

USING THE TACTICAL RETICLE SYSTEM

MIL DOT / TMR® / SPR® / CM-R2™ USAGE INSTRUCTIONS

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The Leupold®
Mil Dot and Tactical Milling Reticle

The Leupold® Mil Dot and Tactical Milling Reticle (TMR®) employ a system based on the subtension of one milliradian (mil) from the center of one dot (Mil Dot) or full hash mark (TMR) to the center of the next dot or full hash mark. This subtension also applies from the center of the reticle to the center of the first dot or full hash mark in any direction.

The principle behind Leupold's TMR is to expand on existing mil dot reticle designs by offering users more ranging tools in the form of various sized and various spaced aiming points on the horizontal and vertical stadia. This allows greater ranging and shooting precision than all previous range estimating reticle systems. The TMR reticle subtends exactly like all existing mil dot reticles and generations thereof, but with greater accuracy. Aside from mil hash marks, the

TMR reticle offers areas of .2 mil subdivisions to precisely measure the common one meter target quickly from 500 to 1,000 meters and beyond. This has previously been the most difficult task in long-range shooting, since this entire range lies in the span between one and two mils. The position of the .2 mil subdivisions are intentionally placed on the periphery of the fine crosshair in order to keep the central area clutter free. All existing mil dot calculations and formula tools are compatible with the Leupold TMR design.

Parts of the Leupold Mil Dot and TMR Reticle

A milliradian is a unit of measure derived from the degrees of a circle (in a 360 degree circle, there are 6,283.2 milliradians, or 17.45 milliradians per degree.) This means that a milliradian will subtend different amounts at different ranges. For example:

The subtension of 1 mil equals 3.6 inches at 100 yards or 36 inches at 1,000 yards. In metric units, the correspondence is 1 mil equals 10 centimeters at

100 meters or 1 meter at 1,000 meters. Knowing this subtension and knowing the size of the target (or a reference object near the target) allows the distance to the target to be estimated with considerable accuracy.

The base scale for the Mil Dot is 1.0 milliradian and the base scale for the TMR is .2 milliradians. The incremental milliradian values designated by various hash marks of the TMR are 5.0, 1.0, .50, .40, .20, .15, or .10 milliradians. The fine cross-hair scale totals 10 milliradians per axis, with the addition of a 5 milliradian hash mark (TMR) on each end post (for a total of 20 milliradians per axis). The scale can be visually subdivided and/or combined by a trained user to produce infinite milliradian reference combinations for limitless target ranging, leading, or hold-over precision. Since the holdover features are presented in milliradian increments, they can be correlated to any ballistic trajectory. Included in this booklet are ballistic values for four popular rounds (see pages 13 -14). The reticle can also be used to estimate windage and lead moving targets in the same manner as all milliradian based reticles.

To use the Mil Dot or TMR simply determine the range to the target using the mil system, then use the corresponding aiming point that is matched to your cartridge to engage the target.

Leupold's TMR uses a mil dot style framework that incorporates a milliradian-based subtension scale for ranging known targets. In addition, the intersection of the crosshair is left open, creating a small, clear aperture for increased precision at longer ranges. Recent findings have determined that existing reticle designs obscure the target at longer distances. The TMR reticle eliminates that problem.

FIRST VERSUS SECOND FOCAL PLANE

In variable-magnification optics, the magnification setting for the use of the Mil Dot or TMR reticle is determined by whether the reticle is in the first or second focal plane. The easiest way to determine if the reticle is in the first focal plane is to view the reticle through the scope while changing the magnification setting. If the size of the reticle appears to change as the magnification setting is changed, the reticle is in the first focal plane. If it does not appear to change size, it is in the second focal plane. If the reticle is in the first focal plane, no specific magnification setting is required to obtain the proper subtension to yield accurate range estimating results.

If the reticle is installed in the second focal plane of an optic, it is calibrated to a specific magnification for range estimating purposes. In a variable-magnification scope, this is generally the highest magnification setting and all range estimating must be performed at this setting. However, in certain scopes it may be calibrated for a different setting. If you are uncertain as to what setting your scope is calibrated, contact Leupold Technical Service at 1-800-Leupold (1-800-538-7653).

THE USE OF A MIL DOT OR TMR RETICLE

To use the Mil Dot or TMR reticle, you must know the actual size of the target.

1. View the target through the scope.

2. Place the center of the crosshair against one edge (top, bottom, or either side) of the target so that the crosshair extends along either its width or height.

3. Using the dots or hash marks, measure along the crosshair to the opposite edge of the target.

If the center of the crosshair is against one edge of the target and the opposite edge of the target is positioned behind the center of the second mil mark, the target measures 2 mils. If it is exactly

between the second and third mil mark, it measures 2.5 mils, etc. The more specific you are in your estimation of the size of the target in mils (2.75 mils, etc.), the more accurate your results will be. This is especially important in estimating the range of a small target or in estimating the range of a target at a great distance (i.e. beyond 500 yards). Once the measurement of the target has been determined in mils, the range can be estimated. This can be done in two ways; either by consulting the charts in this manual or by using the following formula:

(Height of Target in Yards x 1,000) ÷ Height of Target in Mils = Range of the Target in Yards

This formula will also give results in metric terms if meters instead of yards are used in the equation.

For your convenience, Leupold has included range estimating tables (see Tables 1-8). To use these tables, locate the actual size of the target along the top of the table and the apparent size of the target, as measured in mils, along the side of the table. Follow both until they converge. This is the estimated distance to the target.

Using the Data Obtained With the Mil Dot or Tactical Milling Reticle

Once you have estimated the distance to the target with the reticle, there are two primary methods of using this information. Both require that you know the specific bullet drop of the ammunition you are using.

DIALING THE CORRECTION INTO THE SCOPE

The most effective way to use the estimated distance is to dial the necessary correction into the scope using the elevation adjustment. (If your scope features a bullet drop compensation dial, simply dial the correction directly according to the distance marked on the elevation dial.)

1. Calculate the "drop to adjustment increment" ratio of your scope. To do this, use the equation:

Distance to the target in yards ÷ 100 =
Inch value of each minute of angle
or
(Distance to the target in yards ÷ 100) x 2.91 =
Centimeter value of each minute of angle

2. Determine the correction necessary for the target using:

Known bullet drop for distance to target in inches ÷
Inch value of each minute of angle =
Correction to be dialed in minutes of angle
or
Known bullet drop for distance to target ÷
Centimeter value of each minute of angle =
Correction to be dialed in minutes of angle

HOLDING OVER USING THE MIL DOT OR TACTICAL MILLING RETICLE

Sometimes there isn't time for correction using the scope's adjustment mechanisms. In these cases, holding over the target and using the reticle's markings as an aiming point is useful. It must be remembered that holding over is not as exact as dialing elevation. For ease in calculation, assume that one milliradian is 3.6 inches at 100 yards.

1. Calculate the holdover value of each full mil for the distance to the target:

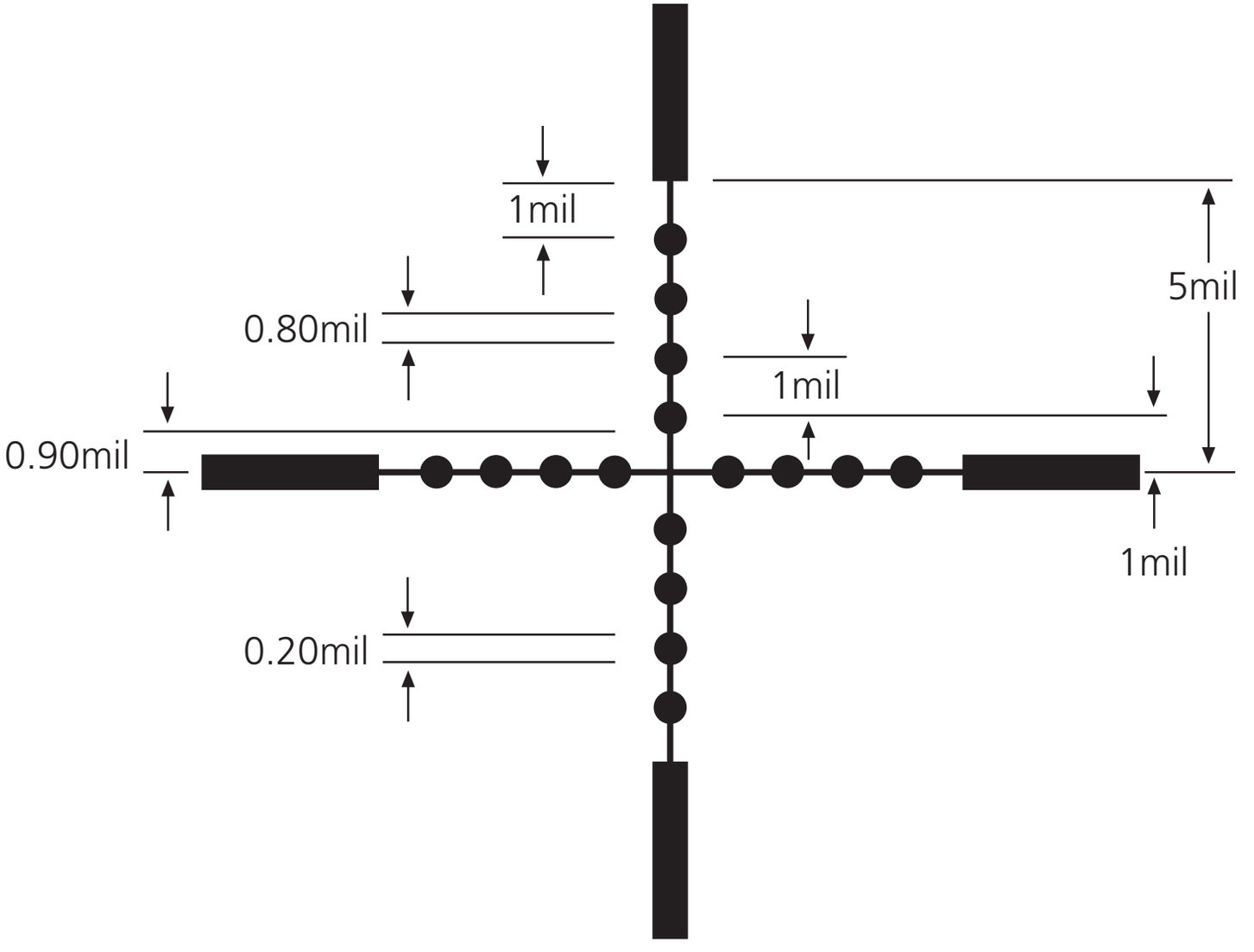
(Distance to the target in yards ÷ 100) x 3.6 =
Inch value from the center of one mil mark to the center of the next at that distance
or
Centimeter value of each minute of angle x 3.6 =
Centimeter value from the center of one mil mark to the center of the next at that distance

2. Calculate the correct holdover:

Known bullet drop at target distance ÷
Inch value from the center of one mil mark to the center of the next at that distance =
Correct holdover for target distance
or
Known bullet drop at target distance ÷
Centimeter value from the center of one mil mark to the center of the next at that distance =
Correct holdover for target distance

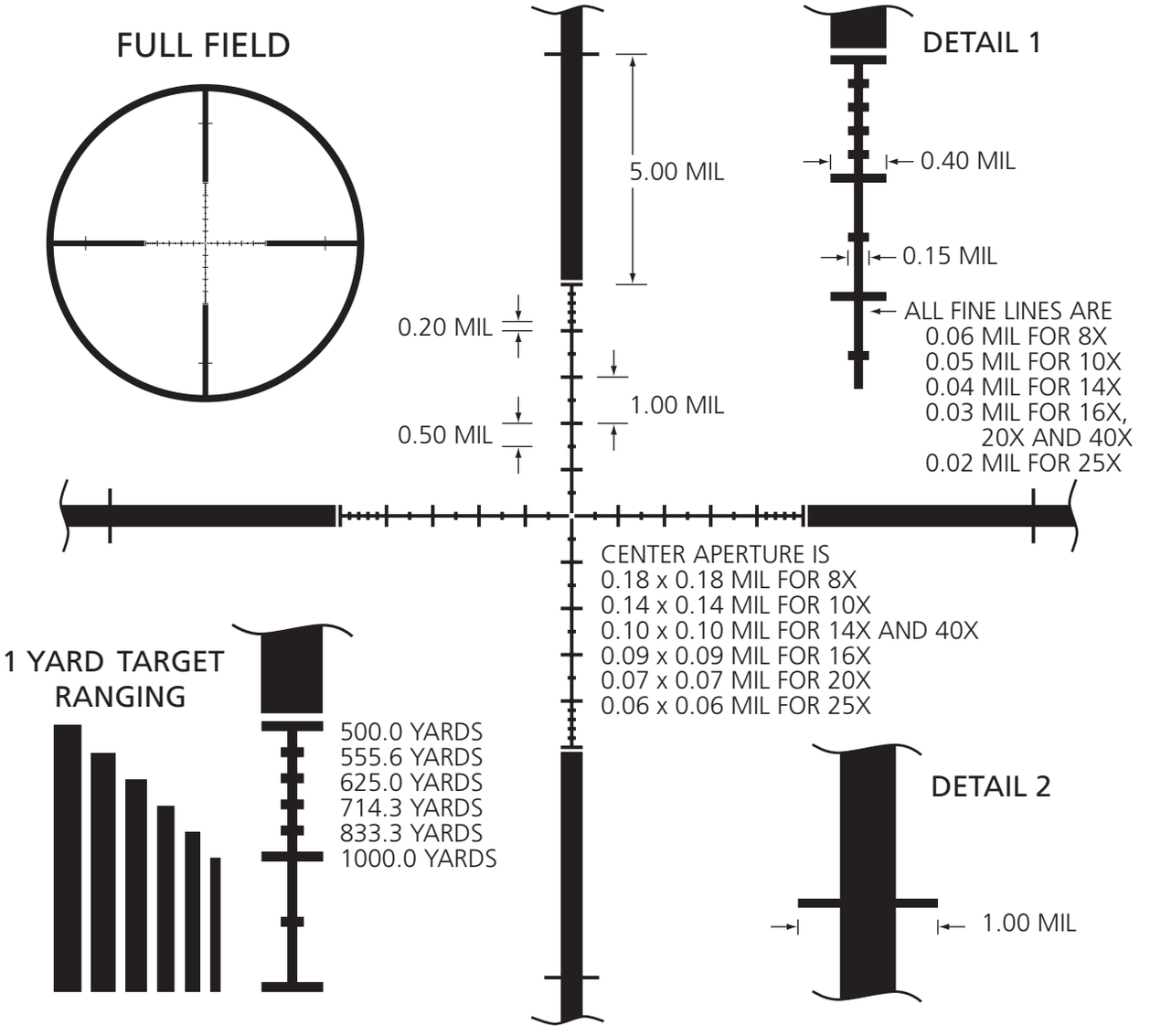
For quick reference on the value of mils at different distances, consult Tables 7 and 8.

MIL DOT RETICLE SUBTENSIONS



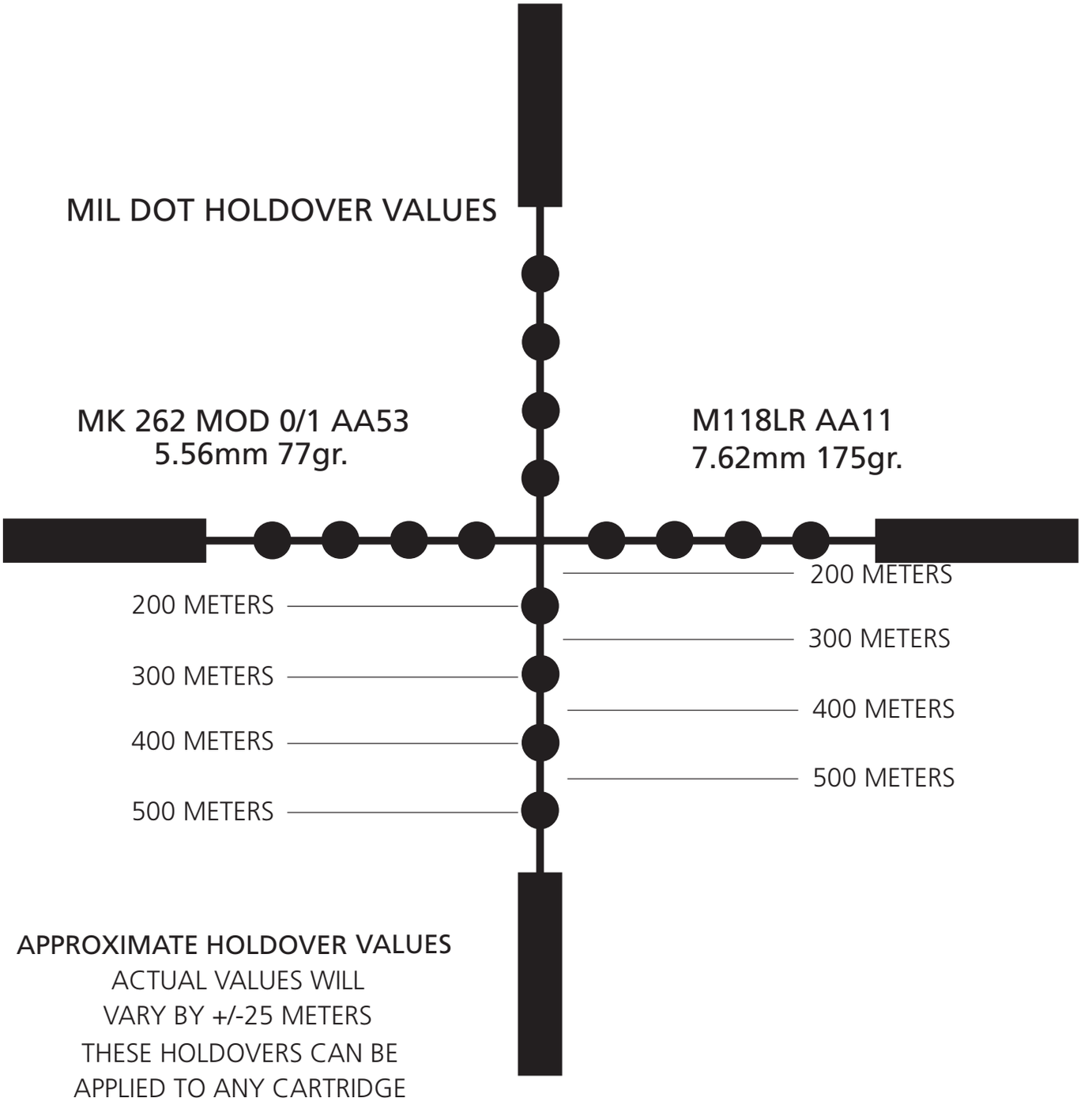
@ 100 YARDS	1 mil = 3.600" 0.9 mil = 3.240" 0.8 mil = 2.880"	0.5 mil = 1.800" 0.2 mil = 0.720" 1 mil = 3.438 Minutes of Angle = 3.600"

TACTICAL MILLING RETICLE SUBTENSIONS



@100 YARDS	5.0 mil = 18.000" 1.0 mil = 3.600" 0.5 mil = 1.800" 0.4 mil = 1.400"	0.20 mil = 0.720" 0.15 mil = 0.54" 0.10 mil = 0.360" 1.0 mil = 3.438 Minutes of Angle = 3.600"

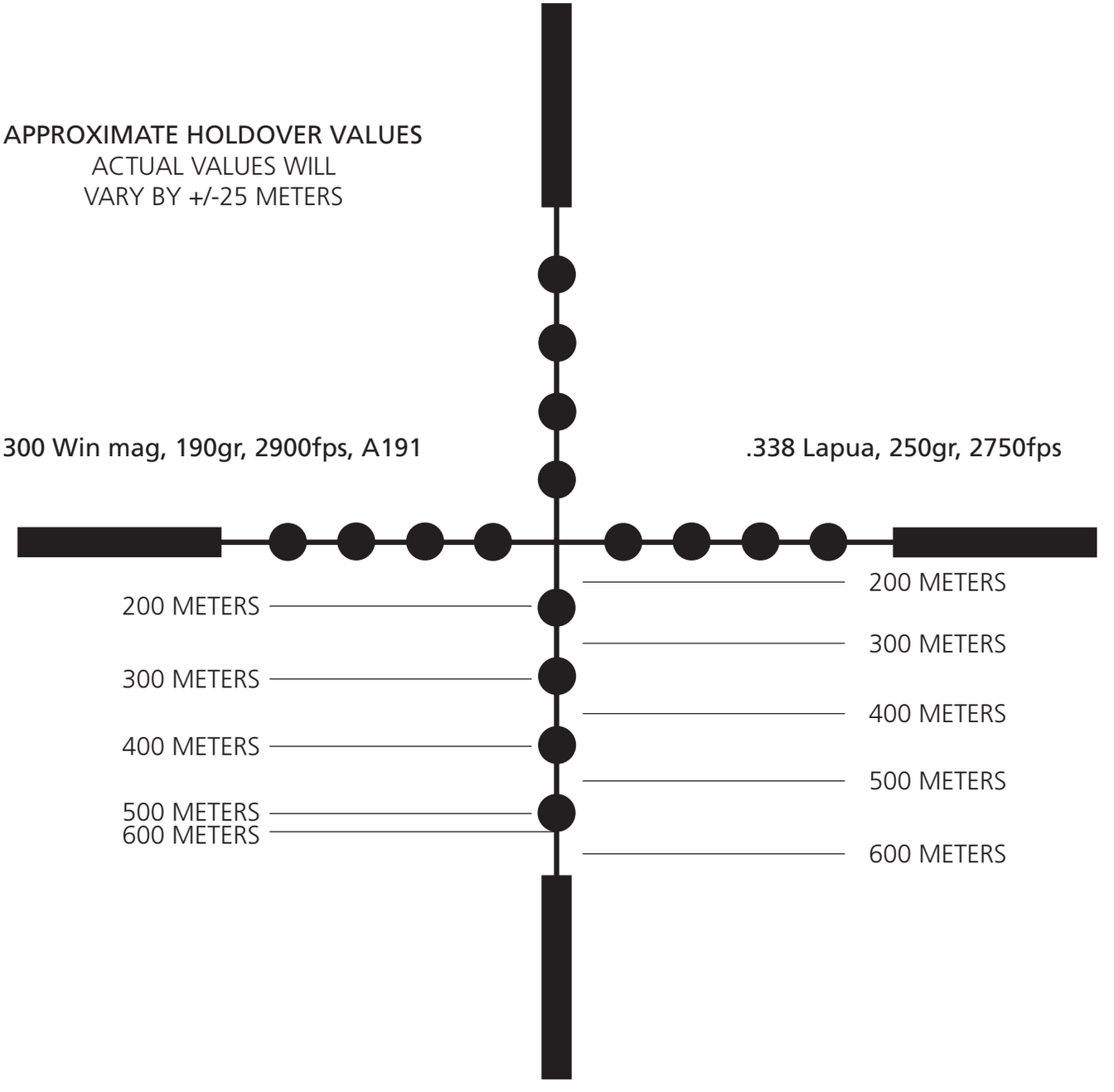
MIL DOT RETICLE HOLDOVER CONCEPT



APPROXIMATE HOLDOVER VALUES
ACTUAL VALUES WILL
VARY BY +/-25 METERS
THESE HOLDOVERS CAN BE
APPLIED TO ANY CARTRIDGE

MIL DOT RETICLE HOLDOVER CONCEPT

APPROXIMATE HOLDOVER VALUES
ACTUAL VALUES WILL
VARY BY +/-25 METERS



YIELDS ESTIMATED TARGET DISTANCE IN YARDS

APPARENT SIZE OF THE TARGET IN MILS	ACTUAL SIZE OF THE TARGET IN INCHES OR YARDS								
	INCHES	9	12	16	18	20	22	24	28	32
	YARDS	0.250	0.333	0.444	0.500	0.556	0.611	0.667	0.778	0.889
	1.00 MIL	250	333	444	500	556	611	667	778	889
	1.25 MIL	200	267	356	400	444	489	533	622	711
	1.50 MIL	167	222	296	333	370	407	444	519	593
	1.75 MIL	143	190	254	286	317	349	381	444	508
	2.00 MIL	125	167	222	250	278	306	333	389	444

Table 1

YIELDS ESTIMATED TARGET DISTANCE IN YARDS

APPARENT SIZE OF THE TARGET IN MILS	ACTUAL SIZE OF THE TARGET IN INCHES OR YARDS								
	INCHES	9	12	16	18	20	22	24	28	32
	YARDS	0.250	0.333	0.444	0.500	0.556	0.611	0.667	0.778	0.889
	1.0 MIL	250	333	444	500	556	611	667	778	889
	1.5 MIL	167	222	296	333	370	407	444	519	593
	2.0 MIL	125	167	222	250	278	306	333	389	444
	2.5 MIL	100	133	178	200	222	244	267	311	356
	3.0 MIL	83	111	148	167	185	204	222	259	296
	3.5 MIL	71	95	127	143	159	175	190	222	254
	4.0 MIL	63	83	111	125	139	153	167	194	222
	4.5 MIL	56	74	99	111	123	136	148	173	198
	5.0 MIL	50	67	89	100	111	122	133	156	178
	5.5 MIL	45	61	81	91	101	111	121	141	162
	6.0 MIL	42	56	74	83	93	102	111	130	148
	6.5 MIL	38	51	68	77	85	94	103	120	137
	7.0 MIL	36	48	63	71	79	87	95	111	127
	7.5 MIL	33	44	59	67	74	81	89	104	119
	8.0 MIL	31	42	56	63	69	76	83	97	111
	8.5 MIL	29	39	52	59	65	72	78	92	105
	9.0 MIL	28	37	49	56	62	68	74	86	99
	9.5 MIL	26	35	47	53	58	64	70	82	94
	10.0 MIL	25	33	44	50	56	61	67	78	89

Table 2

YIELDS ESTIMATED TARGET DISTANCE IN YARDS

APPARENT SIZE OF THE TARGET IN MILS	ACTUAL SIZE OF THE TARGET IN FEET OR YARDS					
	FEET	3	4	5	6	7
	YARDS	1.0	1.3	1.7	2.0	2.3
	1.0 MIL	1,000	1,333	1,667	2,000	2,333
	1.5 MIL	667	889	1,111	1,333	1,556
	2.0 MIL	500	667	833	1,000	1,167
	2.5 MIL	400	533	667	800	933
	3.0 MIL	333	444	556	667	778
	3.5 MIL	286	381	476	571	667
	4.0 MIL	250	333	417	500	583
	4.5 MIL	222	296	370	444	519
	5.0 MIL	200	267	333	400	467
	5.5 MIL	182	242	303	364	424
	6.0 MIL	167	222	278	333	389
	6.5 MIL	154	205	256	308	359
	7.0 MIL	143	190	238	286	333
	7.5 MIL	133	178	222	267	311
	8.0 MIL	125	167	208	250	292
	8.5 MIL	118	157	196	235	275
	9.0 MIL	111	148	185	222	259
	9.5 MIL	105	140	175	211	246
	10.0 MIL	100	133	167	200	233

Table 3

YIELDS ESTIMATED TARGET DISTANCE IN METERS

APPARENT SIZE OF THE TARGET IN MILS	ACTUAL SIZE OF THE TARGET IN CENTIMETERS						
	CENTIMETERS	30	40	50	60	70	80	90
	1.00 MIL	300	400	500	600	700	800	900
	1.25 MIL	240	320	400	480	560	640	720
	1.50 MIL	200	267	333	400	467	533	600
	1.75 MIL	171	229	286	343	400	457	514
	2.00 MIL	150	200	250	300	350	400	450

Table 4

YIELDS ESTIMATED TARGET DISTANCE IN METERS

APPARENT SIZE OF THE TARGET IN MILS	ACTUAL SIZE OF THE TARGET IN CENTIMETERS							
	CENTIMETERS	30	40	50	60	70	80	90
	1.0 MIL	300	400	500	600	700	800	900
	1.5 MIL	200	267	333	400	467	533	600
	2.0 MIL	150	200	250	300	350	400	450
	2.5 MIL	120	160	200	240	280	320	360
	3.0 MIL	100	133	167	200	233	267	300
	3.5 MIL	86	114	143	171	200	229	257
	4.0 MIL	75	100	125	150	175	200	225
	4.5 MIL	67	89	111	133	156	178	200
	5.0 MIL	60	80	100	120	140	160	180
	5.5 MIL	55	73	91	109	127	145	164
	6.0 MIL	50	67	83	100	117	133	150
	6.5 MIL	46	62	77	92	108	123	138
	7.0 MIL	43	57	71	86	100	114	129
	7.5 MIL	40	53	67	80	93	107	120
	8.0 MIL	38	50	63	75	88	100	113
	8.5 MIL	35	47	59	71	82	94	106
	9.0 MIL	33	44	56	67	78	89	100
	9.5 MIL	32	42	53	63	74	84	95
	10.0 MIL	30	40	50	60	70	80	90

Table 5

YIELDS ESTIMATED TARGET DISTANCE IN METERS

APPARENT SIZE OF THE TARGET IN MILS	ACTUAL SIZE OF THE TARGET IN METERS					
	METERS	1.00	1.25	1.50	1.75	2.00
	1.00 MIL	1,000	1,250	1,500	1,750	2,000
	1.50 MIL	667	833	1,000	1,167	1,333
	2.0 MIL	500	625	750	875	1,000
	2.5 MIL	400	500	600	700	800
	3.0 MIL	333	417	500	583	667
	3.5 MIL	286	357	429	500	571
	4.0 MIL	250	313	375	438	500
	4.5 MIL	222	278	333	389	444
	5.0 MIL	200	250	300	350	400
	5.5 MIL	182	227	273	318	364
	6.0 MIL	167	208	250	292	333
	6.5 MIL	154	192	231	269	308
	7.0 MIL	143	179	214	250	286
	7.5 MIL	133	167	200	233	267
	8.0 MIL	125	156	188	219	250
	8.5 MIL	118	147	176	206	235
	9.0 MIL	111	139	167	194	222
	9.5 MIL	105	132	158	184	211
	10.0 MIL	100	125	150	175	200

Table 6

VALUE OF MILS IN INCHES AT DISTANCES MEASURED IN YARDS

MILS	DISTANCE TO THE TARGET IN YARDS								
	YARDS	100	150	200	250	300	350	400	450	500
	1.0 MIL	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0
	1.5 MIL	5.4	8.1	10.8	13.5	16.2	18.9	21.6	24.3	27.0
	2.0 MIL	7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0
	2.5 MIL	9.0	13.5	18.0	22.5	27.0	31.5	36.0	40.5	45.0
	3.0 MIL	10.8	16.2	21.6	27.0	32.4	37.8	43.2	48.6	54.0
	3.5 MIL	12.6	18.9	25.2	31.5	37.8	44.1	50.4	56.7	63.0
	4.0 MIL	14.4	21.6	28.8	36.0	43.2	50.4	57.6	64.8	72.0
	4.5 MIL	16.2	24.3	32.4	40.5	48.6	56.7	64.8	72.9	81.0
	5.0 MIL	18.0	27.0	36.0	45.0	54.0	63.0	72.0	81.0	90.0

Table 7

VALUE OF MILS IN CENTIMETERS AT DISTANCES MEASURED IN METERS

MILS	DISTANCE TO THE TARGET IN METERS								
	METERS	100	150	200	250	300	350	400	450	500
	1.0 MIL	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
	1.5 MIL	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0
	2.0 MI	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0
	2.5 MIL	25.0	37.5	50.0	62.5	75.0	87.5	100.0	112.5	125.0
	3.0 MIL	30.0	45.0	60.0	75.0	90.0	105.0	120.0	135.0	150.0
	3.5 MIL	35.0	52.5	70.0	87.5	105.0	122.5	140.0	157.5	175.0
	4.0 MIL	40.0	60.0	80.0	100.0	120.0	140.0	160.0	180.0	200.0
	4.5 MIL	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0
	5.0 MIL	50.0	75.0	100.0	125.0	150.0	175.0	200.0	225.0	250.0

Table 8

THE LEUPOLD SPECIAL PURPOSE RETICLE (SPR)

The Leupold Special Purpose Reticle (SPR) was designed to allow users to successfully engage targets with greater flexibility than generally possible with other reticle styles. This reticle also preserves the instinctive fire capabilities of the Leupold Circle Dot reticle in short range, low magnification engagements typical of 3-gun competition and Close Quarter Battle in the 21st century. This unique blend of capabilities allows the various optics platforms equipped with this reticle to perform equally well in open desert, heavy cover, or the urban environment.

A key component in the operation of the Leupold Special Purpose Reticle is the ability to estimate range using the milliradians (mils) scale. A milliradian is a unit of measure that corresponds to different distances at different ranges. For example:

The subtension of 1 mil equals 3.6 inches at 100 yards or 36 inches at 1,000 yards. In metric units, the correspondence is 1 mil equals 10 centimeters at 100 meters or 1 meter at 1,000 meters. Knowing this subtension and knowing the size of the target (or a reference object near the target) allows the distance to the target to be estimated with considerable accuracy.

The SPR Reticle is comprised of three heavy posts connected by fine stadia lines, much like the German #4 reticle. On the fine stadia,

large tic marks are located at 5 mil intervals, with small tics bisecting the large tics which indicate 2.5 mil intervals. A large center circle of 10 mil diameter surrounds a fine, .3 mil dot which is located at the intersection of the fine crosshair and provides a quick point of acquisition. Fine stadia are .1 mil thick, while thicker posts are .5 mil thick. The 2.5 mil tic marks are .3 mil wide, while the wider 5 mil hash marks are .5 mil wide. All subtensions indicated are with the riflescope set on the highest power. The result is a reticle that allows numerous different measuring possibilities and almost limitless ranging ability for the trained operator.

The hash marks and tic marks on the vertical crosshair are calibrated to two popular long range service rounds, the 5.56mm NATO SS109 at 2800 fps (carbine velocity) and the 7.62mm NATO 118 LR at 2600 fps (rifle velocity). After properly zeroing the rifle or carbine, the tic marks will correspond with bullet drop at these ranges (see table 9 on page 26). Actual distance values can vary by +/- 20 meters at the indicated distance depending on actual target size.

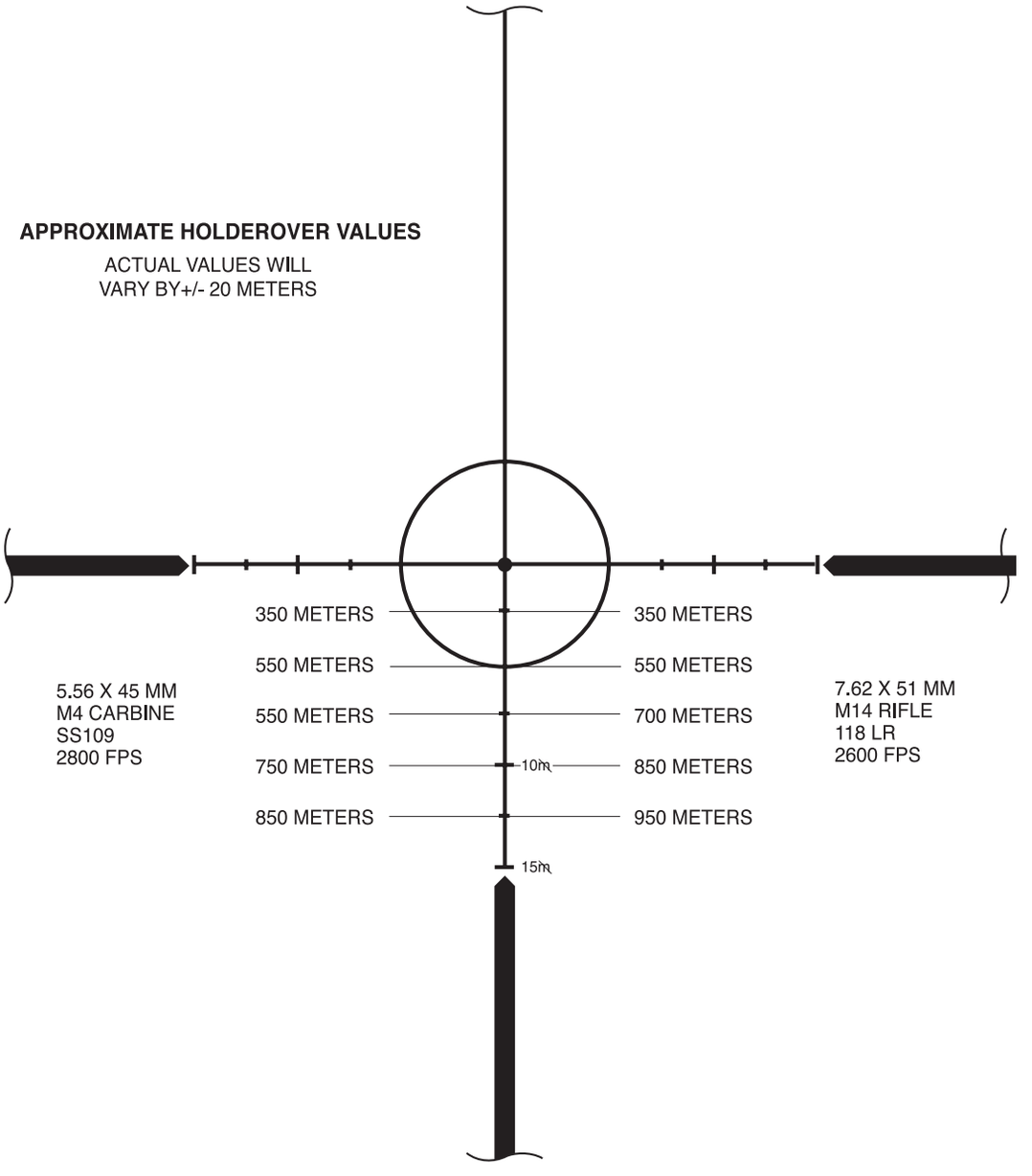
As can be seen from the accompanying diagram (Table 10) the mil tic marks and hash marks can be used as range estimating devices, provided a target of 1 or 2 meter height is available. This range estimating ability will allow the user to quickly and accurately estimate distance and engage targets at longer ranges. At close range, the large circle allows rapid target acquisition when ranging is not necessary and the target is still within the Point Blank Range (PBR) of the weapon.

To use the system, accurately estimate the range to the target using the mil system, then, use the corresponding aiming point that is matched to your cartridge to engage the target. For targets that are inside 200 yards, a center mass shot can be achieved by using the center aiming dot and a 100 yard zero.

TABLE 9

APPROXIMATE HOLDEROVER VALUES

ACTUAL VALUES WILL
VARY BY+/- 20 METERS



5.56 X 45 MM
M4 CARBINE
SS109
2800 FPS

7.62 X 51 MM
M14 RIFLE
118 LR
2600 FPS

TABLE 10

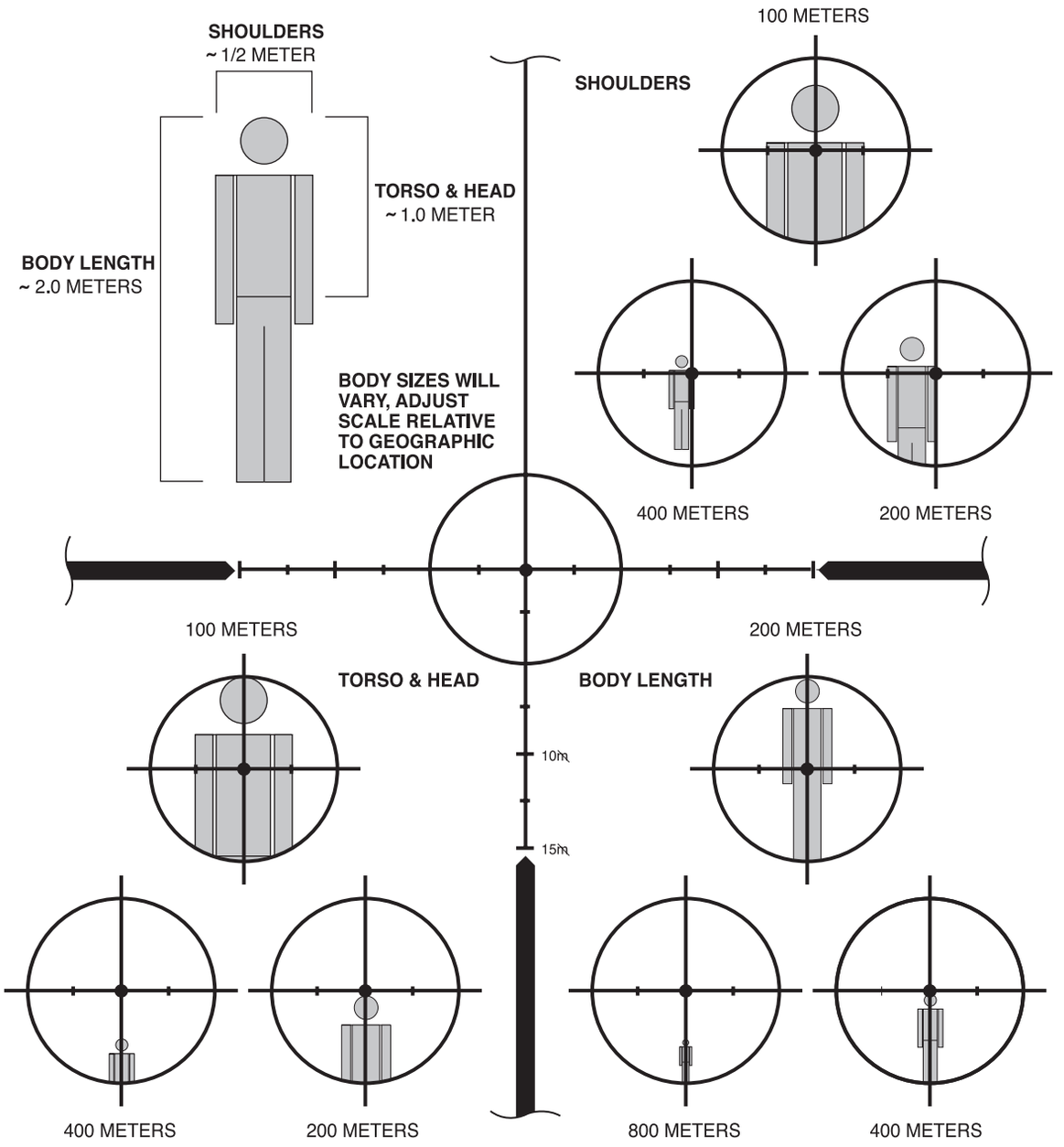
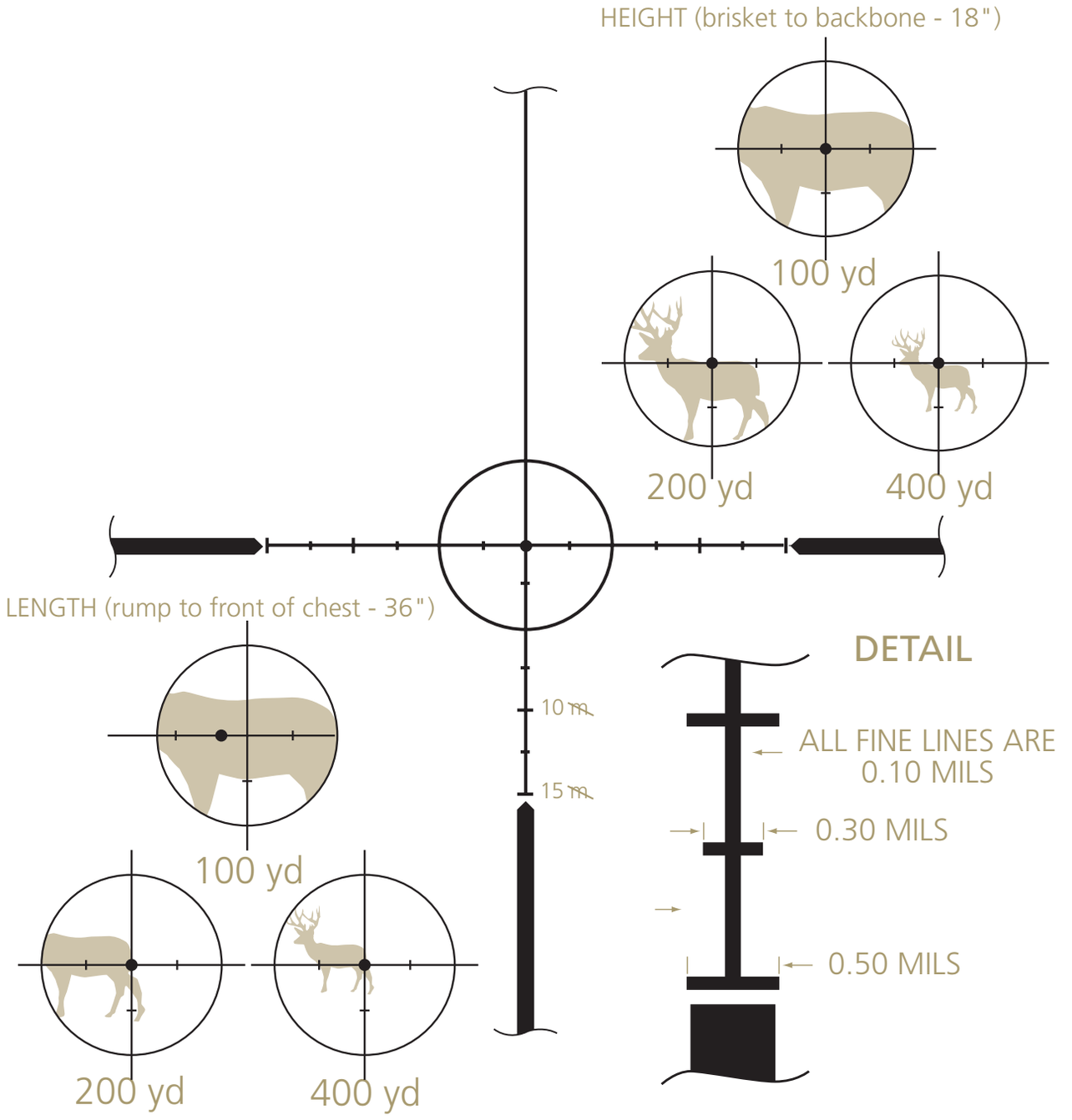

SHOULDERS
~ 1/2 METER
TORSO & HEAD
~ 1.0 METER
BODY LENGTH
~ 2.0 METERS
BODY SIZES WILL VARY, ADJUST SCALE RELATIVE TO GEOGRAPHIC LOCATION
100 METERS
SHOULDERS
400 METERS
200 METERS
100 METERS
200 METERS
TORSO & HEAD
BODY LENGTH
10m
15m
400 METERS
200 METERS
800 METERS
400 METERS

TABLE 11

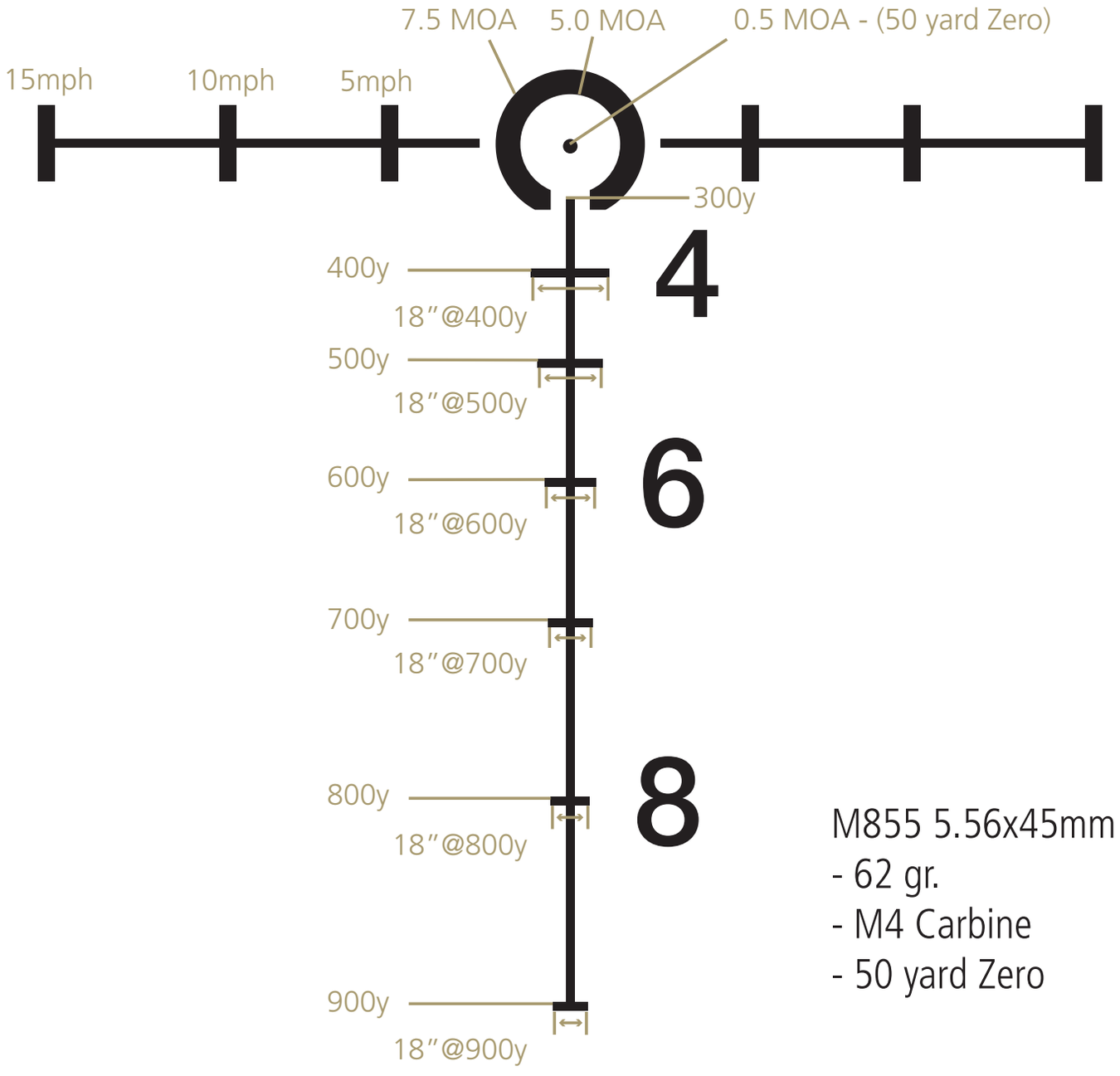

HEIGHT (brisket to backbone - 18")
100 yd
200 yd
400 yd
LENGTH (rump to front of chest - 36")
100 yd
200 yd
400 yd
10 m
15 m
DETAIL
ALL FINE LINES ARE
0.10 MILS
0.30 MILS
0.50 MILS

THE LEUPOLD CLOSE MID-RANGE RETICLE (CM-R²)

Much like the SPR reticle, the CM-R² was designed to allow users to successfully estimate range and engage targets with greater flexibility than generally possible with other reticle styles. This reticle also preserves the instinctive fire capabilities of the Leupold Circle Dot reticle in short range, low magnification engagements typical of 3-gun competition and Close Quarter Battle in the 21st century. This unique blend of capabilities allows the various optics platforms equipped with this reticle to perform equally well in open desert, heavy cover, or the urban environment.

The CM-R² reticle is comprised of a 0.5 MOA dot surrounded by a 5.0 MOA circle for a perfect combination of precision and speed. The hash marks on the horizontal stadia can be used for leading targets moving at 5, 10, and 15 mph respectively. The tic marks on the vertical stadia serve a dual purpose, allowing the user to quickly estimate the distance to 18" targets while serving as precise holdover points for targets between 300 and 900 meters. For best results, the CM-R² reticle should be zeroed at 50 yards using M855 5.56mm NATO/.223 Remington ammunition producing a muzzle velocity of 2810 fps with 62 grain FMJ bullets.

CM-R² RETICLE SUBTENSIONS



M855 5.56x45mm NATO
- 62 gr.
- M4 Carbine
- 50 yard Zero

Leupold Technical Service

To contact Leupold Technical Service or to get a free catalog, write to: Leupold & Stevens, Inc., P.O. Box 688, Beaverton, OR 97075-0688; call **1 800 LEUPOLD (538-7653)** or **(503) 526-1400**; or send us an e-mail through our Web site at **www.leupold.com**.

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